eralizations in a time and place, as do the numerous illustrations she (and her publisher) have included. You come away from this book with a good sense of the changing atmosphere of the office, the personalities of the organizers, and the feelings of those who fought against bureaucratization—and lost.

Yates is firmly on the side of this important aspect of modernization, that is, the achievement of greater efficiency through standardization and tighter control. In that sense, she adopts the values of those business leaders who led the drive for business combination, centralization of control, and administrative consolidation, major themes in U.S. business between the 1880s and 1930s. She might, I think, have given more thought to how innovation fitted into the movement for centralization. She hints at a relationship in her treatment of communications at DuPont's research and development organization, but the theme calls for more elaborate development. The controls she describes were well suited to top-down innovation in a setting characterized by adversarial labor relations and standardized operations. The controls improved efficiency by making the people involved replaceable parts in a tightly controlled bureaucratic system. They did not encourage process or product innovations on the shop floor. In effect, business traded that sort of bottom-up innovation for the immediate gains to be realized through systematic management, American style. Eventually U.S. business would pay a big price for adversarial labor relations and the style of innovation it sustained. There was thus a downside to centralization to which Yates might have given more consideration in light of her concern with using "historical events" to "illuminate current problems and issues" (p. 275).

There is little else to complain about in this solidly researched and carefully reasoned account. Yates sets her study firmly in a broad context stressing (à la Alfred D. Chandler) the growth of large enterprise and modern management. She thus avoids the kind of intellectual fragmentation that has taken place in the bottom-up style of social and political history. Throughout, she helps her readers by carefully defining the terms she uses. She distinguishes between so-called "scientific" and "systematic" management, wisely stressing the latter and much broader movement. She shows us precisely how business developed an "organizational memory" and when businessmen learned to use it effectively to manage. As they did so, depersonalization and alienation became problems, and Yates discusses these negative dimensions of the drive to replace ad hoc with systematic controls. Some firms responded with in-house magazines trying, one editor explained, to "humanize our magazine with concentrated personality" (p. 75). We will never know what "concentrated personality" actually achieved, but we are very much in Yates's debt for showing us how these tensions developed and how firms tried to deal with them.

Products of size, complexity, and technical change, these problems as well as the modes of control that helped create them were essential aspects of the process of bureaucratization that has transformed modern society. Some lament it. They will sympathize with General Henry DuPont, who stoutly refused to let a newfangled typewriter into his office. Others applaud the new age. They will sympathize with Pierre S. DuPont, the Apostle of System. Whether we like or detest it, we all experience the managerial society every day of our lives. We should be grateful to Yates for describing and analyzing a crucial phase in the emergence of that society, for establishing the importance of leadership in bringing these changes about, and for assuring us that the new controls were not simply an inevitable consequence of technological forces over which mortals had no control.

Louis Galambos
*Johns Hopkins University,
Baltimore, MD 21218*

Post-Origin Paleontology

Mass Extinctions. Processes and Evidence. Stephen K. Donovan, Ed. Columbia University Press, New York, 1989. xiv, 266 pp., illus. $45.

Long before Brazilians with buzz saws, a student of taxonomic death could have observed clams suffocating in anoxic waters, ferns freezing from climatic change, or perhaps even dinosaurs vaporized by meteorites. *Mass Extinctions: Processes and Evidence* is the most recent addition to an already sizable number of books on such past extinctions. Most of these books are either loosely organized symposium volumes or single-authored books presenting personalized views. Donovan's goal in this book is to do what these other books do not: provide a primary reference work that coherently summarizes the growing literature. In my opinion, he has succeeded.

The 12 chapters in this book are generally well-written overviews by specialists in each subject. The first three are devoted to general considerations, comprising a historical perspective of mass extinction studies (Hoffman) and explications of the key role of paleontology in mass extinction studies (Donovan) and of the geochemistry of bioevent horizons (Orth). The next nine chapters are summaries of current knowledge of nine major extinction events. These include the "big five," ending the Ordovician, Devonian, Permian, Triassic, and Cretaceous periods, as well as extinctions toward the end of the Precambrian, Cambrian, Eocene, and Pleistocene.

Though each chapter is generally interesting and informative in its own right, some important impressions emerge from the collective whole. One is the sheer quantity of data on these past events. An impressive array of stratigraphic, paleontological, geochemical, and many other lines of evidence is displayed as each author attempts to reconstruct the biotic and abiotic events that occurred. Another impression has to do with what is inferred from all these data. In eight of the nine extinctions, climatic or sea-level change is implicated as a major causal perturbation. Only the end-Cretaceous (K-T) event, for which Upchurch concludes that a bolide impact is most harmonious with the data, differs. Yet even here there is evidence that long-term climatic change was also involved.

To the well-versed reader, there is a good deal of *déjà vu* here. Any good historical geology textbook of 1960s vintage can be found to contain basically the same ideas concerning the causes of most of these events. Obviously, there has been much necessary refinement of the data, but are we mainly learning more and more about less and less? Judging from this book, the answer is no, because the most important impression of all is how most authors go beyond a simple laundry list of what died, when, and what abiotic process pulled the trigger. They broach what may well be the next phase of mass extinction research: increased analysis of the role of biotic properties and biotic dynamics in extinctions. For too long, "explanations" of mass extinctions have focused on identifying abiotic "perturbations" (either single or coincidental). True enough, in some catastrophes such explanations are about all there is: if a massive bolide erases all life and landscape in a wide area, knowledge of the abiotic input just about says it all. In most cases, however, especially where habitats are altered gradually, the causal chain to extinction will include many biotic variables. Crucial among such variables are biotic properties that cause some groups to go extinct while others do not (selectivity) and biotic interactions that are themselves the cause of extinction (secondary extinctions caused by previous abiotic deletions of species, or extinctions via species additions).

Fully six of the nine extinction-event chapters discuss selectivity and which biotic properties favored survival. McGhee (Devonian), Upchurch (K-T), and Barnovsky (Pleistocene) do an especially thorough job, discussing and documenting how cold-water tolerance, dormancy mechanisms, and small body size provided extinction resistance in their respective events. Similarly, the crucial role of biotic interactions is seen in the effect of species deletions. The high loss of phytoplankton in the Devonian and K-T had effects extending upward through the trophic pyramid, such as the preferential loss of filter feeders. Even "species additions" may have played a key role in the past, as Brasier infers that the appearance of biomineralized jaws and other evolutionary innovations may have helped cause extinctions in the late Precambrian. (A more traditional example would be the Great American Faunal Interchange.)

This shift away from description to causal dynamics in mass extinction research is partly just the logical response to ever-accumulating data. It also seems likely, however, that Earth's ongoing biotic depletion and consequent rise of ecological knowledge of extinction dynamics has influenced those of us who study past declines. Indeed, there seems to be a broad general shift of interest in paleontology away from originations to extinctions. Is it a coincidence that this should happen now, just as, to quote Noel Brown from his plenary address at the recent meeting of the American Institute of Biological Sciences, "Darwin's great age of discovery has succumbed to a great era of extinction"?

Ideally, paleontological interest in biotic extinction dynamics will not only improve our understanding of past events, but, by providing a testing ground on grand spatial and temporal scales, help us gain information useful in minimizing ecological disturbances today. As is teasingly intimated by many papers in this book, perhaps the past can be a laboratory for experimenting with the future.

MICHAEL L. MCKINNEY
Department of Geological Sciences and Graduate Program in Ecology, University of Tennessee, Knoxville, TN 37996-1410

Physics of the Atmosphere

Atmospheric Radiation. Theoretical Basis. R. M. GOODY and Y. L. YUNG. Second edition. Oxford University Press, New York, 1989. xvi, 519 pp., illus. $95.

The next decade of space science may well be remembered for its emphasis on the earth's atmosphere, in response to increasing concern about global climate change and the integrity of the stratospheric ozone layer. If NASA has its way, up to tens of billions of dollars will be spent by the United States, Europe, and Japan on a suite of sophisticated earth observation platforms in geosynchronous and polar orbits, constituting in sum the Earth Observing System or (in Presidential vernacular) the "Mission to Planet Earth."

Goody and Yung's *Atmospheric Radiation: Theoretical Basis* could not have been produced at a better time. The quantity of data returned by spaceborne platforms will be enormous, and many of the data will concern the composition and radiative state of the atmosphere as a function of altitude, latitude, time of day, and season. The inversion of satellite data to retrieve such information is a complex problem in radiative transfer. Likewise, the modeling of climate evolution, currently being pursued through the use of complex numerical codes, boils down in large part to understanding scattering and absorption of radiation by clouds and a range of spectroscopically active gases.

Though presented as a second edition of Goody's classic work by the same title published in 1961, the book is quite different from the original, reflecting the style of the second author as well as the emphasis on climate modeling and retrieval of information from satellite data appropriate to the present state of the atmospheric sciences. Likewise, the explosion in computational ability necessitated the addition of a chapter on methods for solving scattering problems, a subject on which the first edition deferred to Chandrasekhar's classic *Radiative Transfer*. In sum, this is a much-improved volume that builds on the successful style of the original while presenting an impressive array of new material.

One caution is in order regarding the use of the book. Graduate students who have not yet had an introductory course in radiative transfer will find *Atmospheric Radiation* tough going, in spite of the review of basic radiative transfer it includes. Those who will profit most from the book are advanced graduate students or professional scientists who need to gain entry into the fields covered. This reviewer's only quibble is that the last chapter, on the evolution of an atmospheric thermal disturbance, is rather short and may leave readers thirsting for more details.

Atmospheric Radiation provides an admirable balance between the mathematical techniques of radiative transfer and the physics of line formation by gases of relevance to the terrestrial atmosphere. Though the book is intended to be theoretical, there are thorough connections with current data throughout, as well as a good set of references at the end of each chapter. Some may wish for additional treatment of absorption by molecules appropriate to other planetary atmospheres, particularly those of the outer solar system, but given the length of the book its restriction to the terrestrial atmosphere makes sense. As a rigorous, advanced text this book can be very highly recommended.

JONATHAN I. LUNINE
Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721

NOTE

Contribution no. 89-45 of the Theoretical Astrophysics Program, University of Arizona.

Components of Plants

Plant Cell Wall Polymers. Biogenesis and Biodegradation. NORMAN G. LEWIS and MICHAEL G. PAICE, Eds. American Chemical Society, Washington, DC, 1989. xii, 676 pp., illus. $119.95. ACS Symposium Series, vol. 399. From a symposium, Toronto, ON, June 1988.

This volume offers a much-needed survey of the chemistry, biogenesis, and biodegradation of the major polymers of plant cell walls, a subject sadly neglected until relatively recently. As with many volumes based on symposium talks, it suffers from the brevity of some contributions and from a lack of unity but gains in the variety of opinions and approaches. The emphasis of the book is on the major wall components, cellulose, hemicelluloses, and lignins, but pectins, non-lignin phenolics, lipids, and proteins are considered briefly. The coverage is divided fairly evenly between the biosynthesis and the biodegradation of these constituents. In addition, the relationship of wall polymers to plant-microbe interactions is discussed. An effective overview of biogenesis is given in an introductory chapter. Though most of the volume will be useful mainly to research investigators and advanced graduate students, there are a number of chapters that suffice to provide a broad view of wall biochemistry for the non-specialist.

I was surprised that plant cell walls are described both by D. H. Northcote and by S. C. Fry and J. G. Miller as extracellular, rather than as extracytoplasmic parts of plant cells. Since these authors' highly informative papers indicate that walls in living cells contain enzymes that are active biosynthetically and are dependent on the organized transport of precursors across the plasmalemma or outer cytoplasmic membrane, I would have expected that they would consider walls integral components of plant